



Space Physics Research Laboratory
Department of Atmospheric, Oceanic & Space Sciences
University of Michigan

A background graphic showing stylized magnetic field lines in white, yellow, and red, arching over a light blue and green gradient background.

Using Geomagnetic Indices in Conjunction with Global Models

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With acknowledgements to Tamas Gombosi, Janet Kozyra and Mike Liemohn

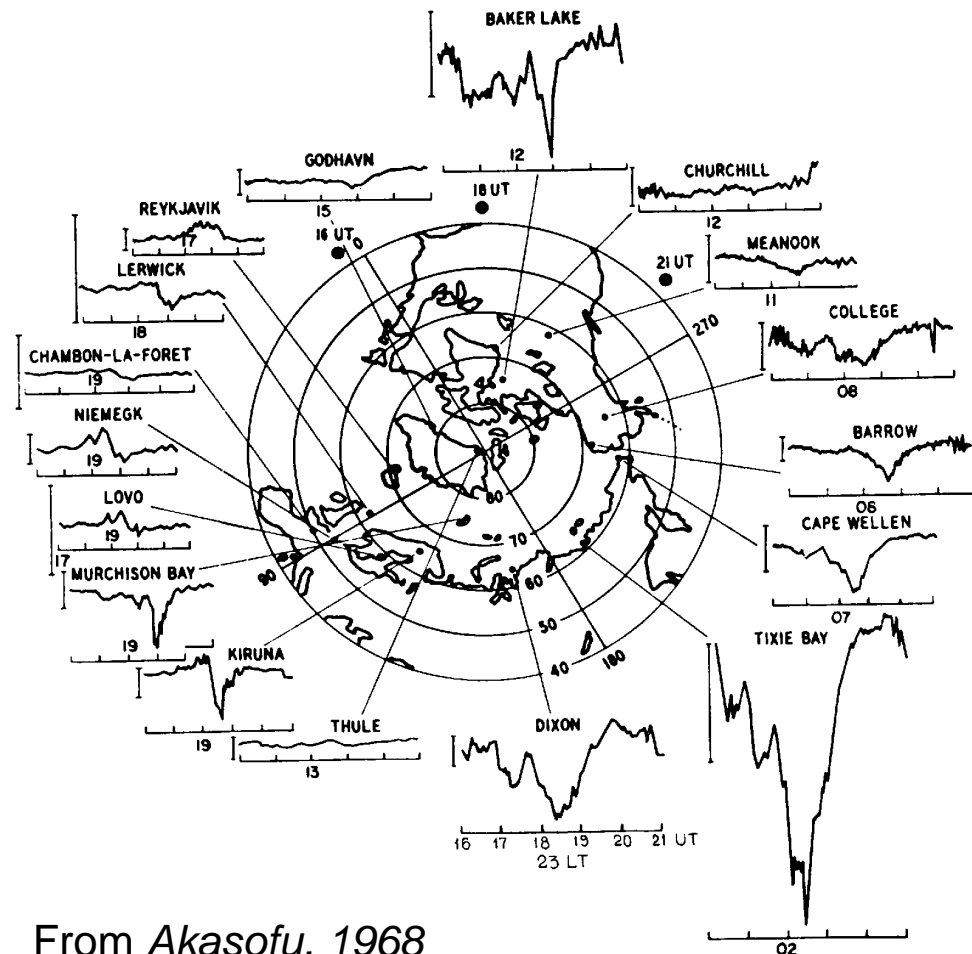


Geomagnetic Indices

- ✓ Synthesize the measurements of (usually) several individual ground magnetic observatories.
- ✓ Originally developed to quantify disturbed states of geospace
- ✓ PC , AE , AU , AL , and D_{ST} quantify the disturbance (and by inference the dissipation of energy) in certain regions.
- ✓ Excellent references on the computation and use of geomagnetic indices are: **Rostoker, G., Geomagnetic Indices, *Rev. Geophys. Space Phys.* 10, 935-950, 1972** and **Appendix 13B in Kivelson and Russell, *Introduction to Space Physics*, Cambridge U. Press, 1995.**

High latitude magnetic variations are sensitive to the local ionospheric Hall currents flowing above the stations.

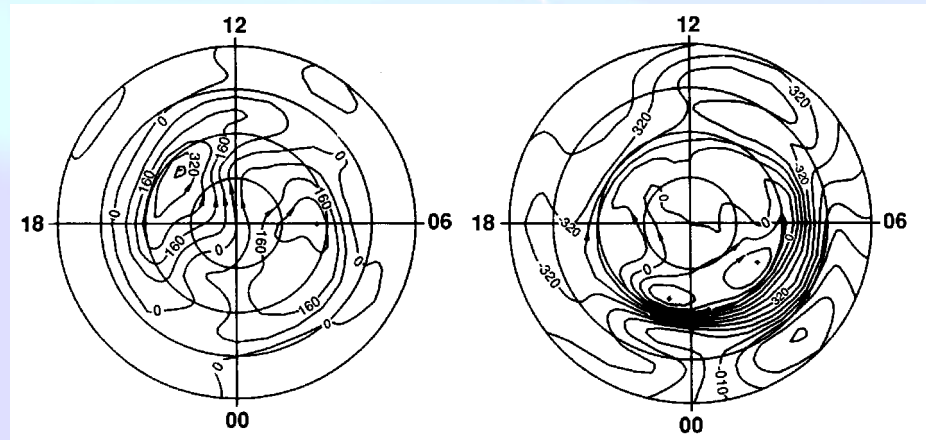
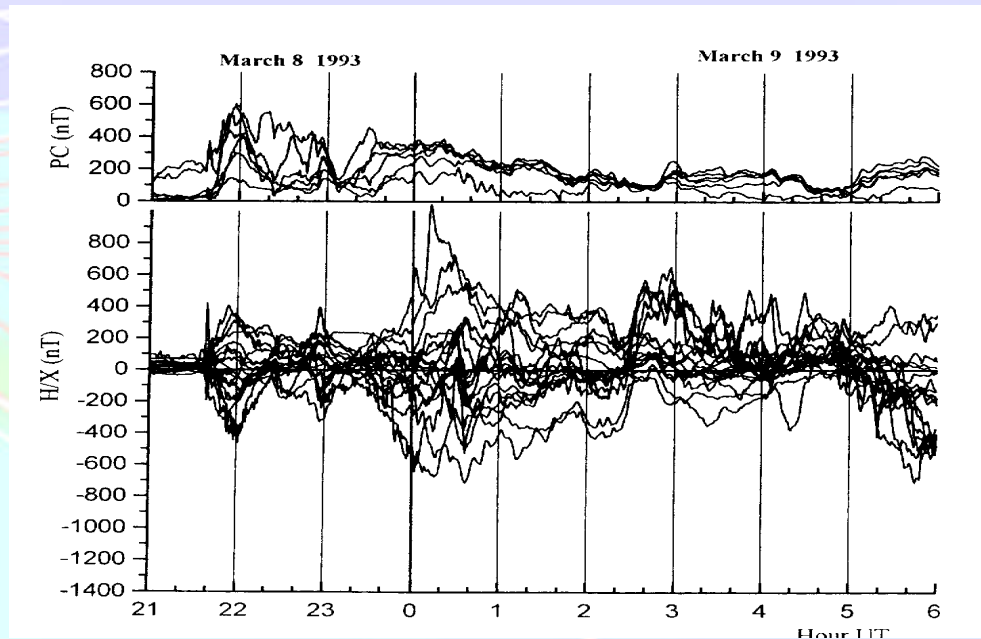
Comparing a simulation output with individual stations can be tricky. A comparison with indices or with statistical patterns may prove more useful.



From Akasofu, 1968

At any instant, polar cap and auroral zone stations may show considerable range in the magnitude of the variation. The **AU**, **AL** and **AE** indices are created by the envelope of the auroral variations.

The **PC** index is created from Vostok (southern) and Thule(northern) data in a scheme to measure the strength of the transpolar portion of the DP2 current system.

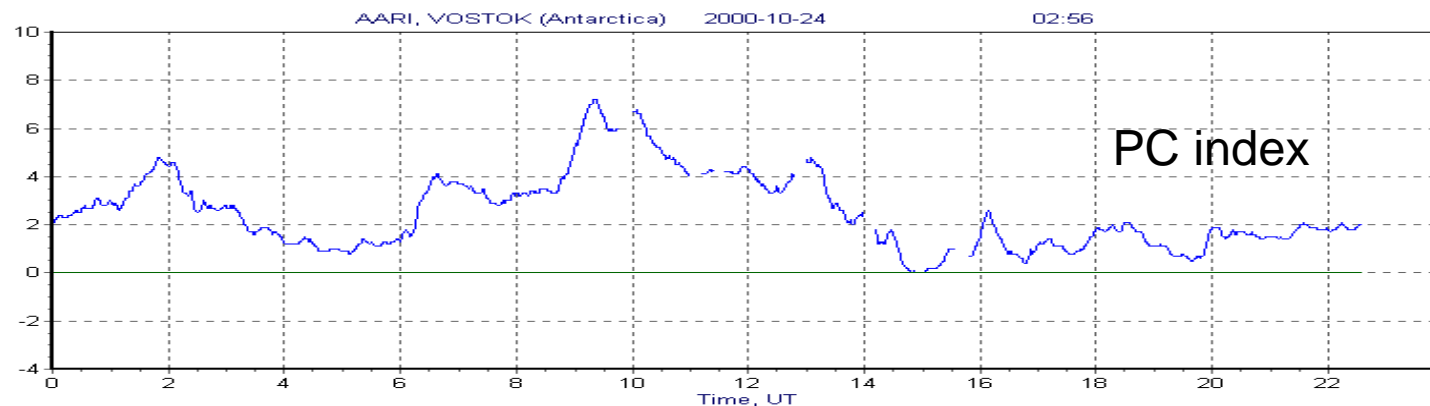


DP2

DP1

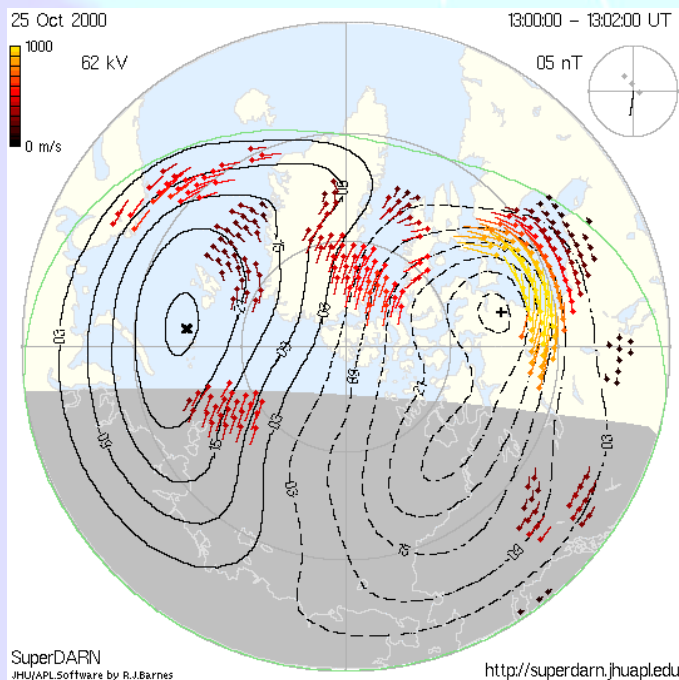
Model Validation Using Event Simulations

- A more difficult test because temporal and spatial variations must be examined.
- Best to use some global scale parameter, such as polar cap potential (GGCM Challenge Metric), PC index,



The PC index is nondimensional parameter characterizing the current state of the magnetosphere (quiet, if $PC < +1$; disturbed, if $PC > 3$). Ref: Troshichev et al. Planet Space Sci. 36, 1095, 1988.
The 1-min PC index is calculated in AARI by technique developed by Lukianova and Troshichev, Scientific report GNTP 05.08, AARI, 1997.

The GGCM challenge to global simulations will utilize the cross polar cap potential as the metric to measure model performance for an event simulation. The cross polar potential will be determined by DMSP measurements and by SuperDARN ground radar measurements of the ionospheric convection (E-field) pattern.



Super DARN global real-time ionospheric convection maps (and associated equipotential contours).

<http://superdarn.jhuapl.edu/>

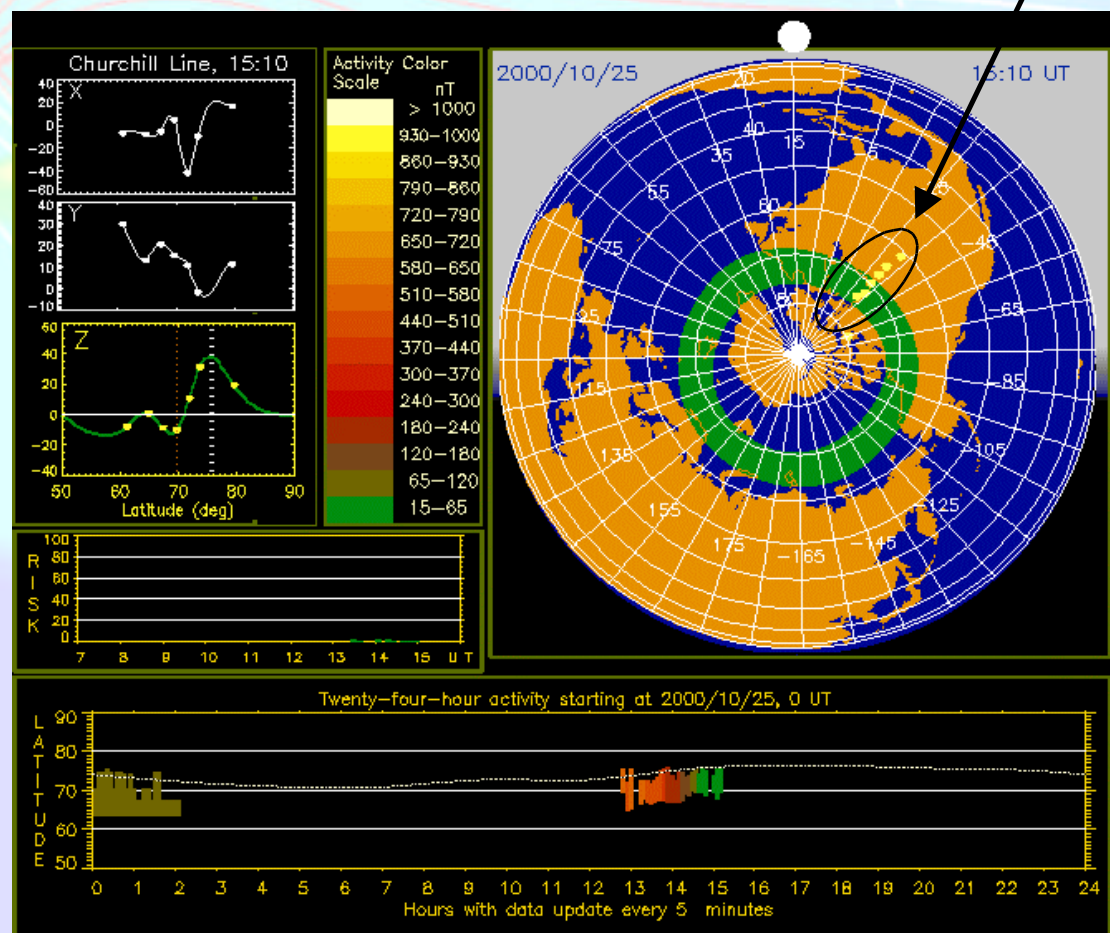


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Comparison with a Meridional Chain

CANOPUS Real Time
Auroral Oval as inferred
from the *CANOPUS*
magnetometer array

Churchill meridional magnetometer chain



<http://www.dan.sp-agency.ca/www/rtoval.htm>

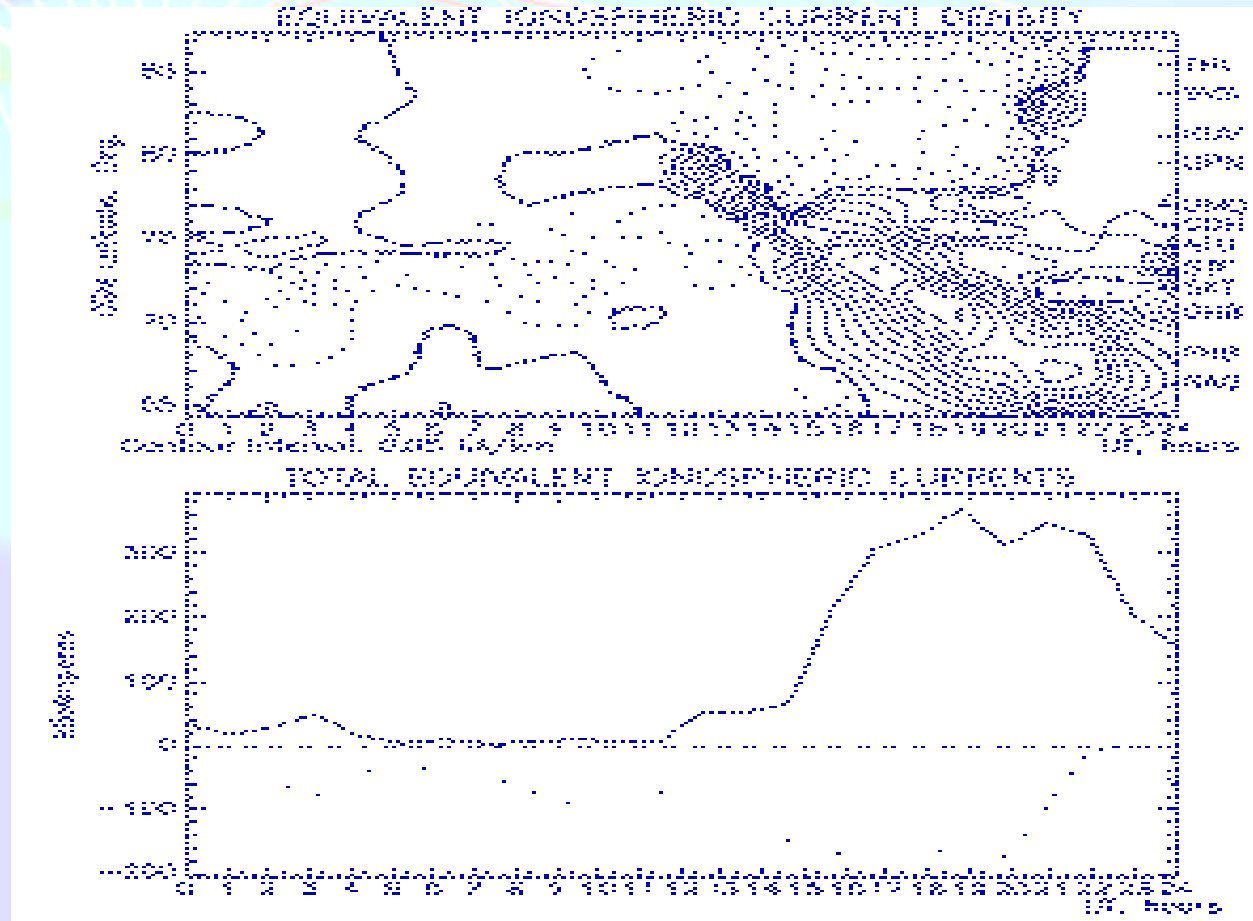


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Comparison with a Meridional Chain

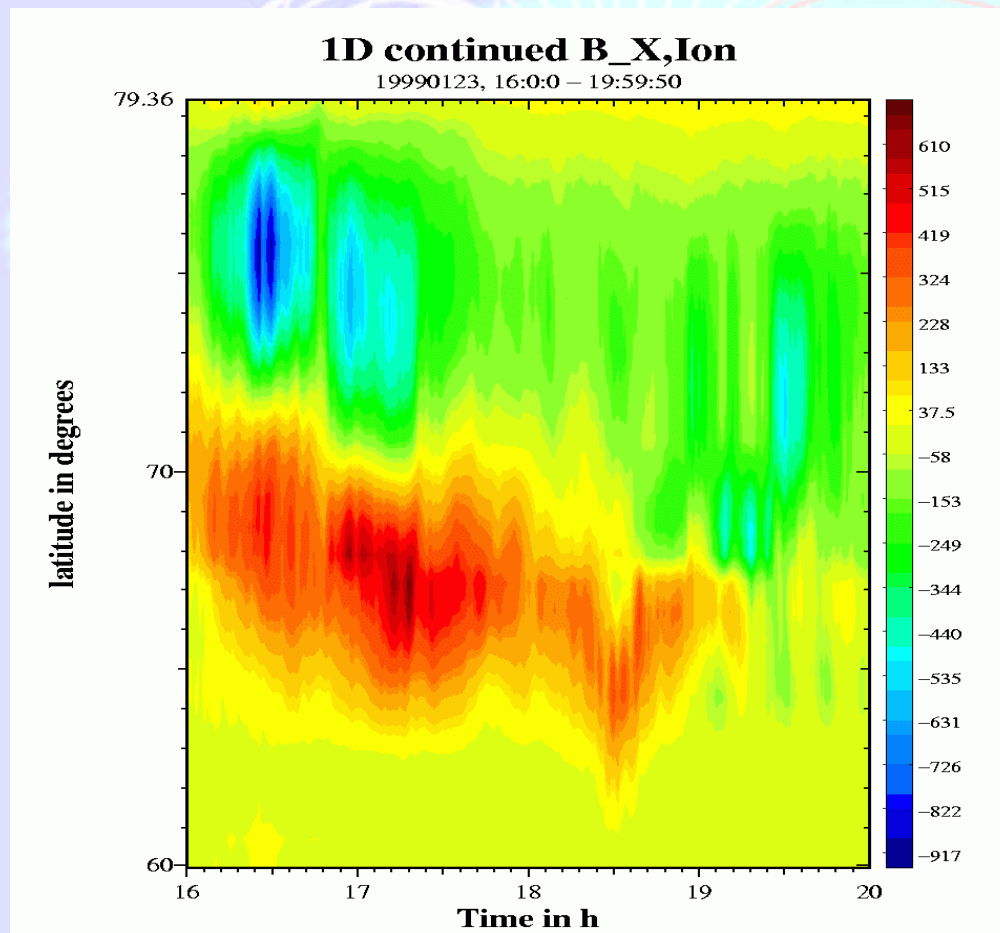
Greenland west
coast meridional
magnetometer
chain inversion
for 03-19-1999

Solid lines => eastward
Dotted lines => westward
Dash-dotted => zero

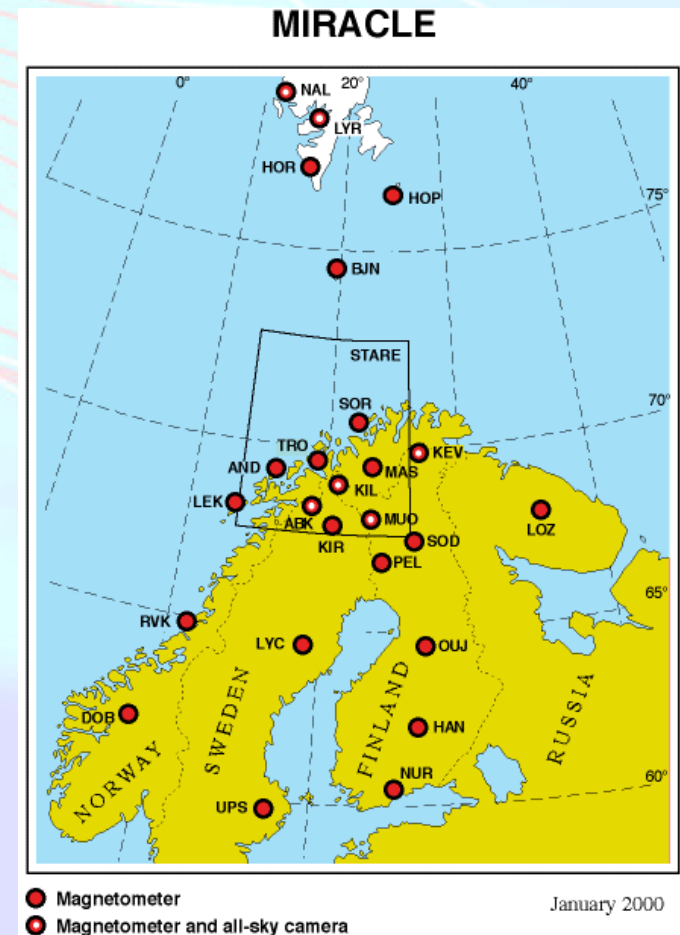


MLT UT - 2

Magnetometers - Ionospheric Radars - Allsky Cameras Large Experiment (MIRACLE)



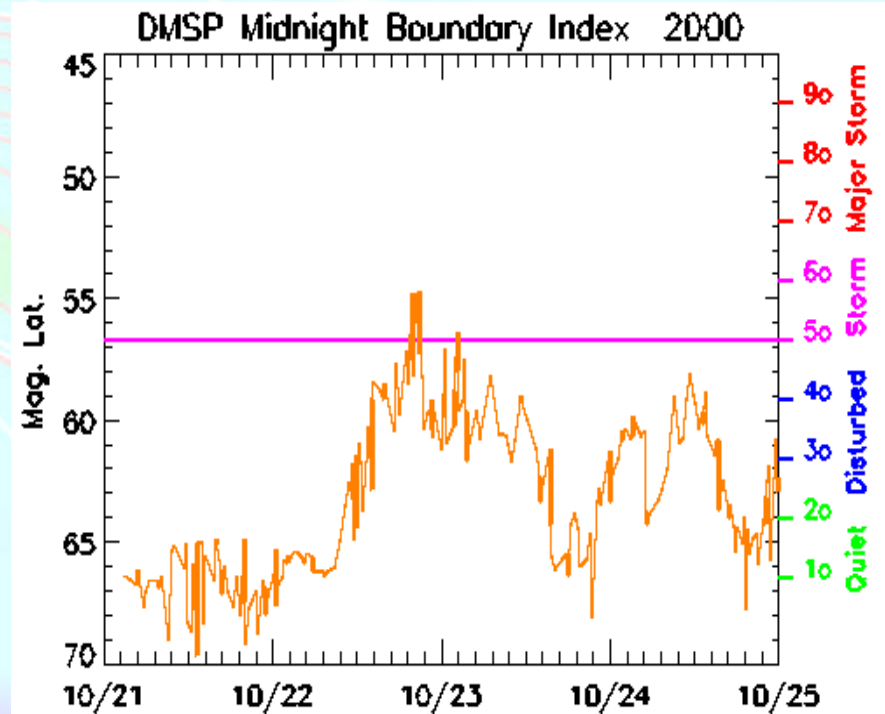
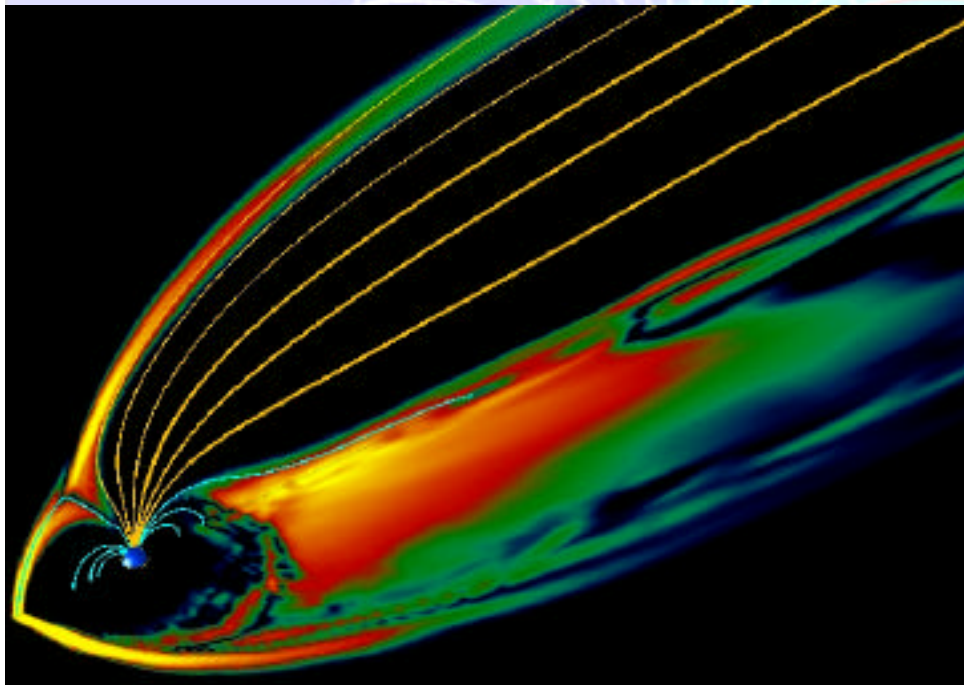
Eastward (red) and Westward (blue) electrojets



● Magnetometer
● Magnetometer and all-sky camera

<http://www.geo.fmi.fi/MIRACLE/>

Midnight Boundary Index



Midnight Boundary Index is derived from the equatorward boundary of precipitating electrons observed by DMSP. Also shown is a statistical estimate of the related Kp value. This could be useful to evaluate the behavior of the tail in a simulation.

http://www-vsbp.plh.af.mil/projects/dmsp/dmsp_recentdata.html

Model Validation Using Idealized Simulations

- Using statistical results for comparison to simulation results makes considerable sense here.
 - For example, statistical patterns of potential, field-aligned current, etc organized by IMF (IZMEM, Weimer, Friis-Christensen, etc.)

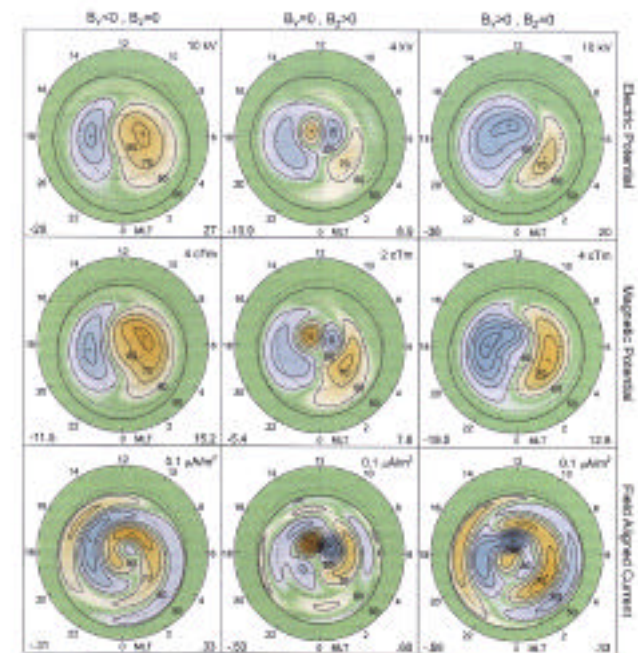
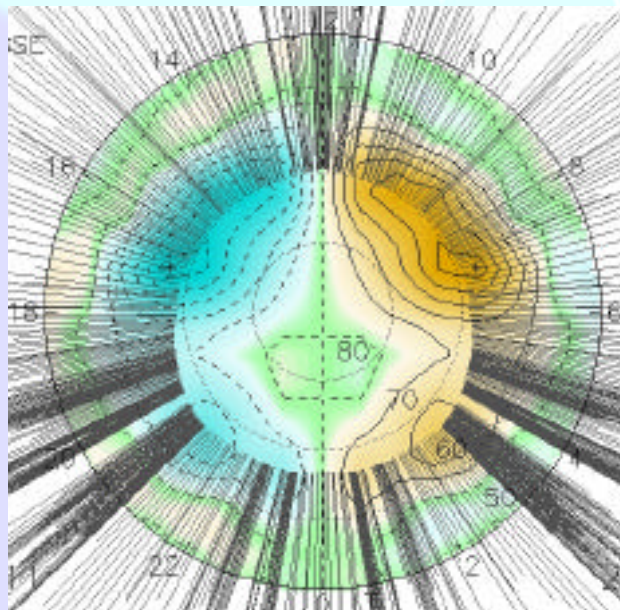
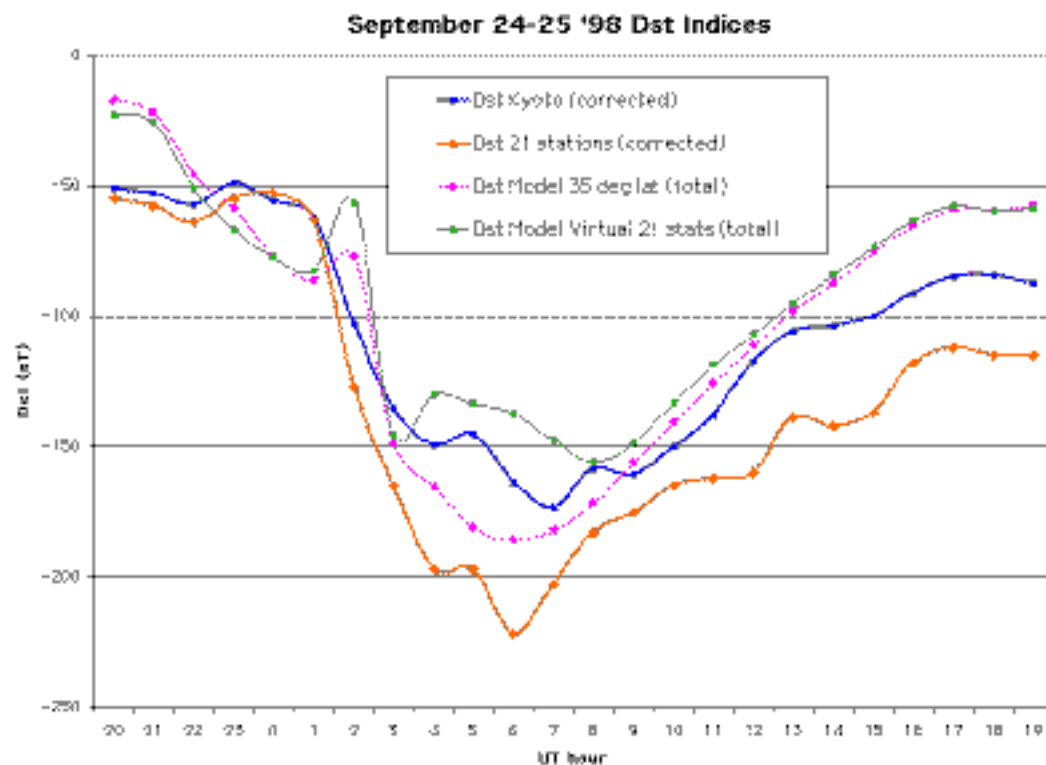


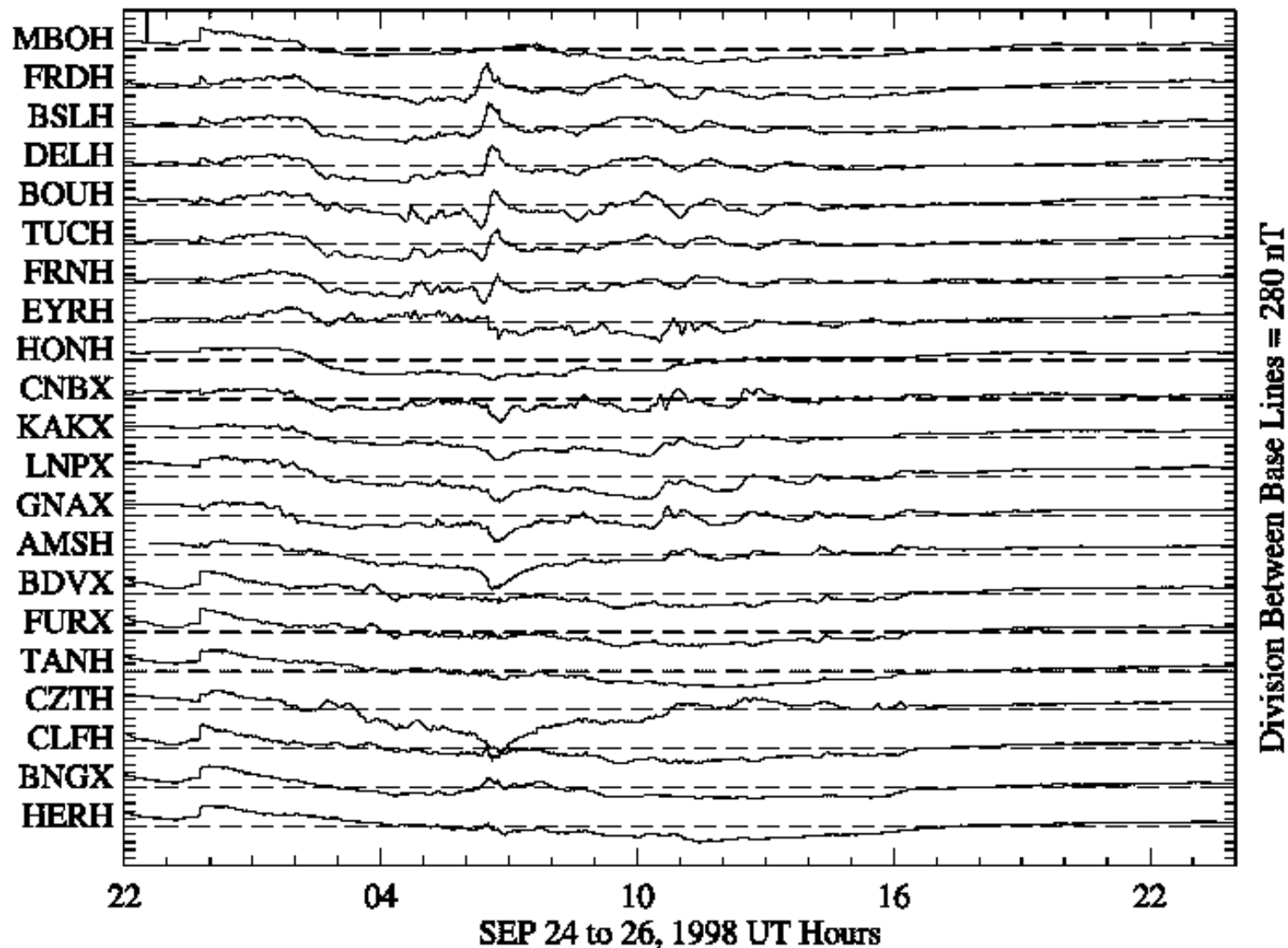
Figure 4. The middle row shows the magnetic field potential that result from a least-squares fit of data from multiple satellite passes. The left column shows the results for data associated with IMF in the -Z direction, the middle column shows the results for IMF in the +Z direction, and the right column shows the results for IMF in the +Y direction. The top row shows the electric potential, and the bottom row shows the maps of the field-aligned currents that are obtained from the magnetic field potential.

D_{ST} and Inner Magnetosphere Models





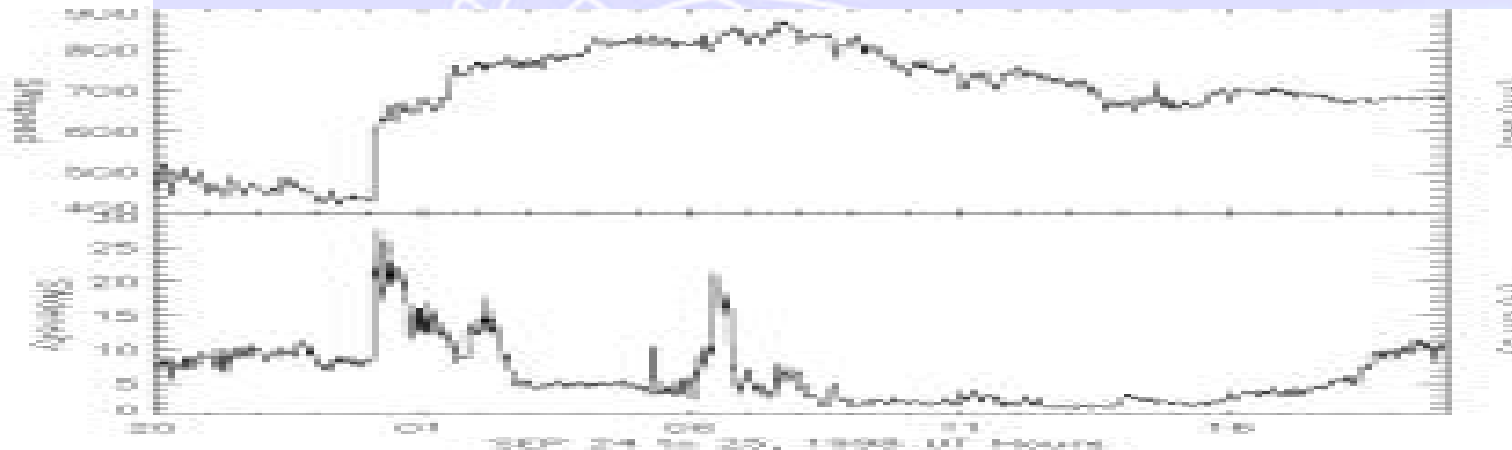
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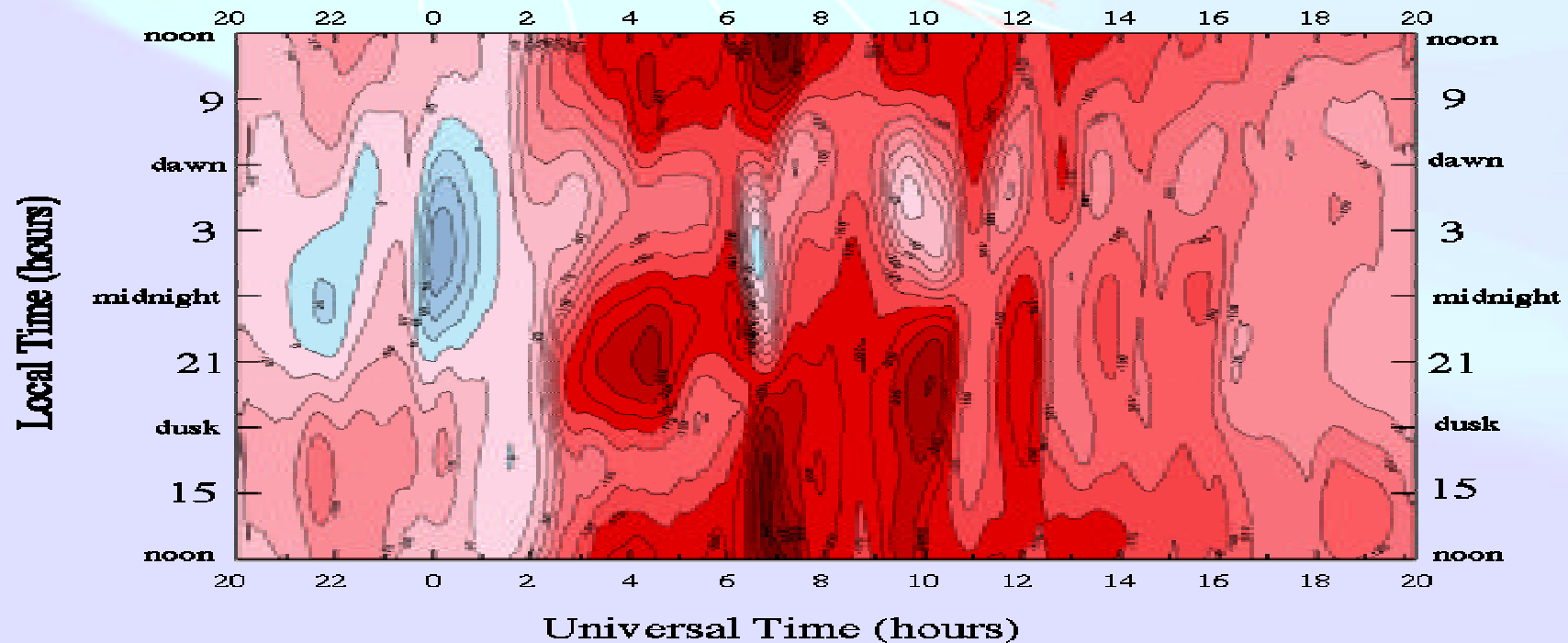


Magnetosphere-Ionosphere
Science Team

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9/24-25/98 : Axial Perturbation (nT)



Comparison of kinetic
ring current model
calculation of the
ground magnetic field
perturbation to
observations.

